

# Analysis of the pathogen spectrum and associated risk factors in sows' Postpartum Dysgalactia Syndrome (PPDS)

Kemper, N. \*,<sup>(1)</sup>, Reiners, K.<sup>(2)</sup>, Gerjets, I.<sup>(1)</sup>

<sup>(1)</sup> Institute of Animal Breeding and Husbandry, Christian-Albrechts-University, Kiel, Germany

<sup>(2)</sup> PIC Germany GmbH, Schleswig

\*corresponding author: nkemper@tierzucht.uni-kiel.de

## Abstract

This study is part of the research project 'geMMA' ([www.gemma-kiel.de](http://www.gemma-kiel.de)), examining the spectrum of pathogens involved in sows' Postpartum Dysgalactia Syndrome (PPDS) and analysing risk factors concerning this complex puerperal disease. PPDS represents an important disease in sows after farrowing. Serious economic losses come along with the disease due to reduced performance of the sows and increased mortality of the piglets. Prevalence in herds can be as high as 60%. The aetiology of PPDS is multifactorial. Husbandry, management, feeding and hygiene are regarded as influencing factors. Bacterial pathogens are of great importance, but detailed information is lacking. Milk samples of 421 sows with PPDS and 449 non-infected sows of different age were taken on six piglet rearing and fattening units and analysed statistically. Sows were identified as PPDS-infected when the measured temperature was above 39.5°C. Bacteria involved in the pathogenesis of PPDS were identified by advanced bacteriological analysis of this milk including molecular methods like PCR. The results were interpreted with regard to the lines, cycles, seasons, farms and clinical symptoms of the animals. A wide spectrum of pathogens was isolated, belonging mainly to *Enterobacteriaceae*, *Staphylococcaceae*, *Streptococcaceae* and *Enterococcaceae*. *Escherichia coli* played the most important role with isolation rates over 70%. Results of this study underline the influence of the farms and seasons on the occurrence of different bacteria, and of cycle and lines on the PPDS-prevalence in general.

## Introduction

Mastitis in sows, subsumed under the term Mastitis-Metritis-Agalactia (MMA) or Postpartum Dysgalactia Syndrome (PPDS), is an economically important disease complex after farrowing (Gerjets & Kemper, 2009). The affected animals suffer from fever and an inflammation of the mammary glands followed by a reduced milk secretion 24 to 48 hours post partum. The sows fail to meet the needs of their piglets. Reduced productivity of sows, high pre-weaning piglet mortality and growth retardation are the consequences (Waldmann & Wendt, 2001). Incidences in herds can be as high as 60%, with an average of 13% (Krieter & Presuhn, 2009).

PPDS is not transmitted through animal-animal-contact, but influenced by various factors like husbandry, management, nutrition and hygiene. Furthermore, bacterial pathogens play an important role, but detailed information is lacking. In several studies and infection experiments, especially coliform bacteria including the genera *Escherichia*, *Citrobacter*, *Enterobacter* and *Klebsiella* were isolated (Awad Masalmeh et al., 1990; Hirsch et al., 2003). The most important pathogen is *Escherichia (E.) coli*, a gram-negative, rod shaped bacterium with different virulence factors marking its pathogenicity.

## Material and methods

A total of 885 milk samples were obtained, consisting of 432 samples from diseased and 453 samples from healthy sows. After plausibility check, 870 samples in total, 421 samples of diseased and 449 samples from healthy animals, remained. The animals were of different age and housed in the farrowing units of six different farms. They were pure bred (Landrace, Large White) or cross bred (Landrace x Duroc, Large White x Duroc). The sows were identified as PPDS-infected when the measured rectal

temperature was above 39.5°C and the mammary glands showed defined signs of infection. In addition, the appearance and the performance of the piglets were evaluated. Bacteria involved in the pathogenesis of PPDS were identified by advanced bacteriological analysis of the milk samples including molecular techniques like PCR. The results were interpreted with regard to the lines, the cycles and the number of piglets born alive of the sows and the effect of the farms. The statistical evaluation was made with the GENMOD procedure of SAS 9.1.

## Results

A wide spectrum of pathogens was isolated, consisting mainly of coliform bacteria (*E. coli*, *Klebsiella* spp., *Citrobacter* spp., *Enterobacter* spp.), *Staphylococcaceae* (*Staphylococcus* (*Staph.*) *aureus*, *Staph. simulans*, *Staph. chromogenes*), *Streptococcaceae* (*Streptococcus* (*Strep.*) *dysgalactiae*, *Strep. agalactiae*, *Aerococcus* (*Ac.*) *urinae*, *Aerococcus viridans*) and *Enterococcaceae* (*Enterococcus* (*Ec.*) *faecium*, *Ec. faecalis*, *Ec. durans*). Figure 1 shows no differences in the identified bacteria for both healthy and diseased sows except for *S. aureus*. *Staphylococcus aureus* was by tendency significantly more often isolated in sows with PPDS than in healthy ones ( $P=0.09$ ).

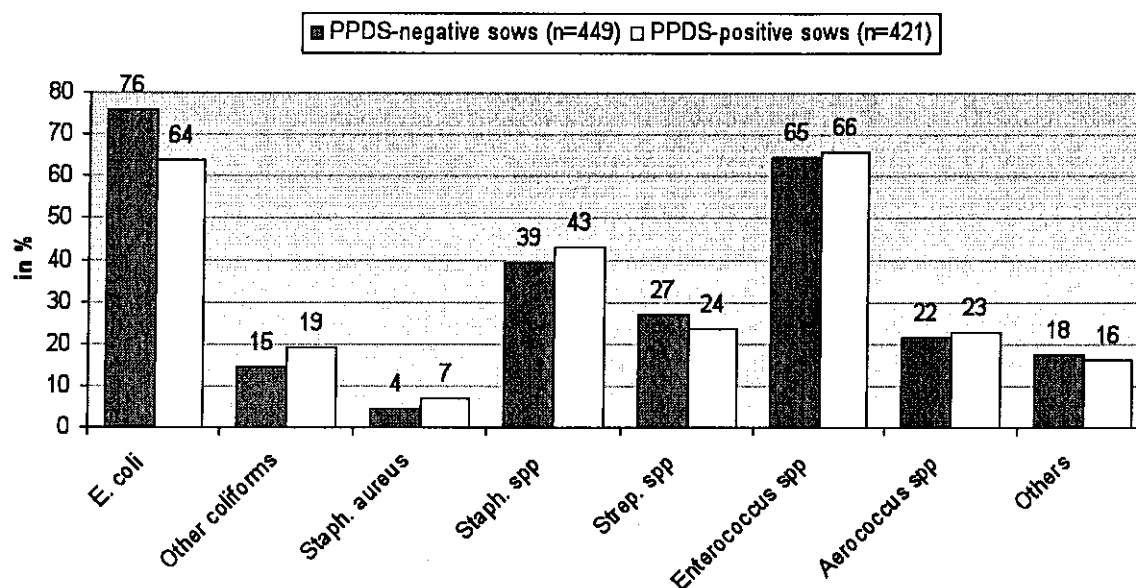


Fig. 1: Bacteriological findings in milk samples of PPDS-infected ( $n=421$ ) and non-infected ( $n=449$ ) sows

The occurrence of PPDS and the results of the bacteriological analysis were statistically examined with regard to the parameters line, cycle, farm and season (table 1). The cycles and lines of the sows had by tendency significant influences on the occurrence of PPDS in general. The influences of the farm, i.e. management and housing, and of the season on most bacteria species were confirmed statistically.

effect	PPDS	<i>E. coli</i>	other coliforms	<i>Staph.aureus</i>	<i>Staph.spp</i>	<i>Strep.spp</i>	<i>Ec.spp</i>	<i>Ac.spp</i>
line	0.0538	0.9664	0.6846	0.5674	0.0916	0.6859	0.8266	0.6157
cycle	0.0924	0.7198	0.3415	0.7092	0.0730	0.3164	<b>0.0272</b>	0.5014
farm	0.6191	<b>&lt;.0001</b>	0.7733	0.2364	<b>&lt;.0001</b>	<b>&lt;.0001</b>	<b>&lt;.0001</b>	0.0749
season	0.3154	<b>0.0259</b>	<b>0.0067</b>	<b>0.0211</b>	<b>&lt;.0001</b>	0.3959	<b>&lt;.0001</b>	0.1483

Tab. 1: Significances of the effects line, cycle, farm and season (significant effects in bold)

## Discussion

Concerning the analysed bacteria spectrum, *E. coli*, *Staph. aureus*, the coagulase-negative staphylococcal species *Staph. simulans* and *Staph. chromogenes* and environmental streptococci are known to cause bovine mastitis, but have also been isolated in studies on porcine mastitis before (Awad Masalmeh et al., 1990; Pyorala, 2008). Coliform bacteria were found more often than the others pathogens. In particular, *E. coli* represented the major part of all isolated bacteria. In 268 of 421 milk samples (64 %) from PPDS-affected sows, *E. coli* was found. These results are in accordance with several other investigations, showing that these pathogens are one causing agent in the etiology of PPDS (Awad Masalmeh et al., 1990; Hirsch et al., 2003).

Faecal contamination of the sows' surroundings represents the most probable source of infection (Awad Masalmeh et al., 1990) and indicates distinctly the need for proper animal hygiene. Ravel et al. (1996) reported that regular washing of the farrowing unit is associated with a lower preweaning mortality. Mammary complexes of sows should be kept clean by reducing the contact with faeces considerably. In a study by Bertschinger et al. (1990), conventional farrowing crates and an experimental pen with a clean resting area were compared, showing a 10 times lower incidence of intramammary *E. coli* infections for sows in the experimental pen.

In our study, the parity numbers had no significant influence on the occurrence of PPDS, but this is discussed controversially: Baer and Bilkei (2005) found a higher parity of the sows (> 4) increasing the occurrence of PPDS. In other studies, a lower parity was postulated as factor contributing to a higher risk of PPDS (Hoy, 2003; Krieter & Presuhn, 2009).

## Conclusions

Bacterial, environmental and animal factors may change the susceptibility for PPDS. These factors are interdependent and the relative influence of each factor is related to the type of pathogens. A holistic approach, considering both husbandry and microbial influences, is needed to cope with future aspects of pig husbandry. This study is a first step in this direction and will be followed by detailed examinations on a larger animal base with further studies on the virulence factors of the isolated *E. coli* and the genetic background of PPDS. Most studies dealing with PPDS were conducted between 1970 and 1990. With particular respect to the economic damages, it is time for research to have a closer look at this syndrome again. A holistic approach, considering both husbandry and microbial influences, is needed to cope with future aspects of pig husbandry. This study was a first step in this direction and will be followed by detailed examinations on a larger animal base with further studies on the genetic background of PPDS.

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### Experimental *Salmonella enterica* infection in market-weight pigs

Rostagno, M.H.\*, Eicher, S.D., Lay Jr., D.C.

USDA, ARS, Livestock Behavior Research Unit, 125 S. Russell Street, West Lafayette, IN 47907, USA.

\*Corresponding author: [Marcos.Rostagno@ars.usda.gov](mailto:Marcos.Rostagno@ars.usda.gov)

#### Abstract

Market pigs infected with *Salmonella* pose significant food safety risk by carrying the pathogen into abattoirs. A study was conducted to determine the dynamic of *Salmonella* infection in market-weight pigs (220-240 lbs.). Pigs (n=24) were individually inoculated (intranasally;  $10^8$  cfu/mL) with *Salmonella enterica* serovar Typhimurium. Fecal samples were collected from each pig, and 3 pigs were randomly selected and euthanized to collect additional samples (spleen, liver, mesenteric lymph node, ileal and cecal contents) on days 1, 2, 7, 14, 21, 28, 35, and 42 post-inoculation (p.i.). All samples were processed for the isolation and enumeration of the challenge strain used. No inoculated animal showed any clinical sign of the infection. Bacteriological data revealed that all inoculated pigs started shedding *Salmonella* within 24 h p.i., and persistently shed the bacteria up to the end of the study (i.e., 6 weeks). Ileal and cecal content samples were all positive throughout the study. Mesenteric lymph nodes were also positive during the entire study and at the same level as intestinal content samples. All samples contained 3-4 logs (cfu/g) of *Salmonella* at 24 h p.i., and 4-5 logs (cfu/g) of *Salmonella* up to 4 wk p.i. Interestingly, levels of *Salmonella* dropped markedly ( $P<0.05$ ) in all samples at 5 wk p.i., being detectable only by bacteriological enrichment. Understanding the dynamic of *Salmonella enterica* infection in market-weight pigs will enable the pork industry to develop and plan the application of intervention strategies that will contribute to increase pork safety.